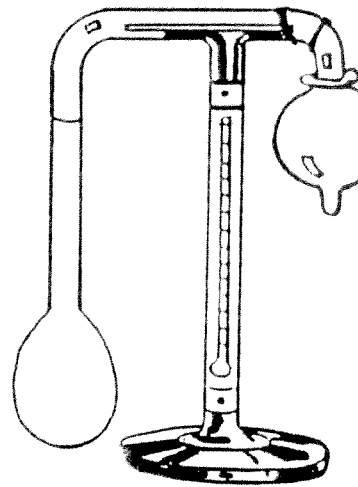
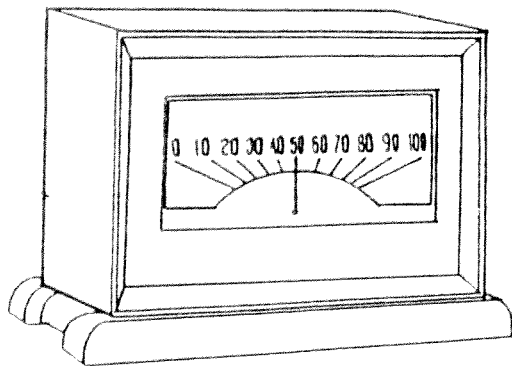


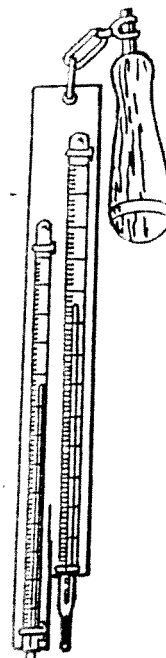
USING A HYGROMETER

A *hygrometer* is used to measure humidity, or the amount of moisture in the air. When the air has all the water vapor it can hold, we say that the relative humidity is 100 percent. When the air holds half as much water vapor as it can, the humidity is 50 percent. Warm air can hold more water vapor than cold air.

A hygrometer shows the humidity with a pointer on a dial. The instrument works by measuring how much a length of hair stretches as the humidity increases. Hair hygrometers only remain accurate for a few months, because the hair collects oil and dirt, so meteorologists usually use a psychrometer, which measures how much a wet object is cooled as it dries in the air. In the classroom, students can simply read a hygrometer to check the humidity.



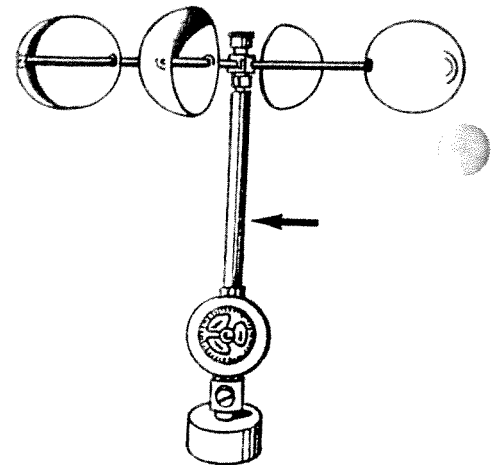
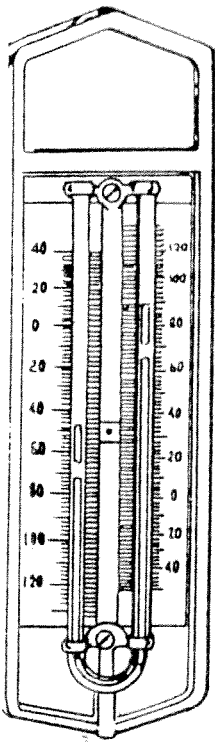
A **psychrometer** measures relative humidity, using the cooling effect of evaporation. Two thermometers are used in a psychrometer. Notice that a wet cloth covers the end of one of the thermometers. Water evaporates from this cloth, causing the temperature on that thermometer to be lower than the other. The person in the picture is finding relative humidity by comparing the two temperatures on a special chart that relates temperature and humidity.



USING A THERMOMETER

The most familiar weather instrument is a thermometer, which measures the temperature of the air. When the air becomes warmer, the red liquid in the bulb at the bottom of the thermometer expands, or grows bigger. (The liquid is usually colored alcohol, or in more accurate thermometers, mercury.) Since the liquid is trapped in the glass tube of the thermometer, the only way the liquid can expand is by moving up the glass tube. When the air becomes colder, the red liquid contracts, or grows smaller, and moves down the glass tube.

Lines on the thermometer show the temperature in degrees. There are 180 degrees between the freezing point of water (32 degrees F) and the boiling point of water (212 degrees F) on the Fahrenheit scale. There are 100 degrees on the Celsius scale between water's freezing point (0 degrees C) and its boiling point (100 degrees C). Meteorologists usually use the Celsius scale.



BEAUFORT WIND SCALE

Meteorologists use an *anemometer* to measure wind speed. One kind of anemometer is made of three cups that spin around a pivoting shaft. Each time the pivot completes one revolution, an electrical contact closes and a lamp flashes in the weather station. The wind speed is measured by counting the number of flashes in a minute. A more modern anemometer looks like a two-foot-long airplane without wings. A propeller powers a small generator inside the anemometer, which drives a speed indicator and an electrical recorder that automatically records the wind speed.

Students probably won't have access to anemometers, but they can use the Beaufort wind scale to keep fairly accurate records of wind speed. The Beaufort wind scale has been widely used from the time it was first invented by an English admiral, Sir Francis Beaufort, early in the nineteenth century. The scale divides winds into thirteen classes based on their speeds. Using the Beaufort wind scale, students can estimate the speed of the wind by observing indications of its force in the world around them.

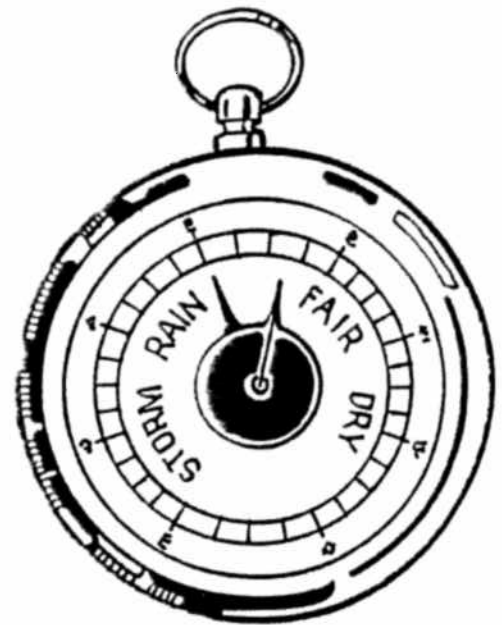
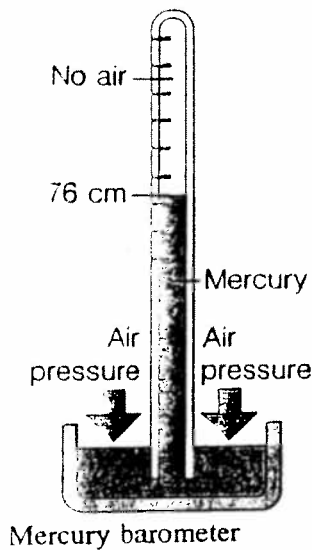
USING A BAROMETER

The most important instrument for forecasting the weather is a *barometer*, which measures air pressure, or the weight of the air. Meteorologists use an international unit of pressure, the *millibar*. Although we can't feel it, the pressure of the atmosphere is usually a little more than 1000 millibars, which is about the same amount of force that an elephant would exert if he balanced on a small desk.

Air pressure is always changing. When the air is cold and dry, it weighs the most. Then the barometer shows high or rising air pressure. An example of high pressure is 1050 mb. High or rising air pressure tells the meteorologist that fair weather is coming. When the air pressure stays high, the weather will probably stay fair and dry.

When air is warm and moist, it weighs less than dry air, and the barometer shows low or falling air pressure. When the pressure is low (for example, 900 mb), the weather is often wet and cloudy. Falling air pressure indicates rainy weather ahead.

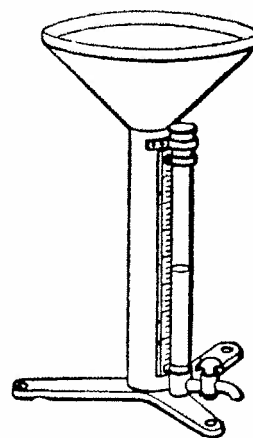
Meteorologists use a mercury barometer that works by balancing the weight of a column of mercury against the weight of a column of air. A mercury barometer is too expensive and delicate for classroom use, but a common aneroid barometer will work.



USING A RAIN GAUGE

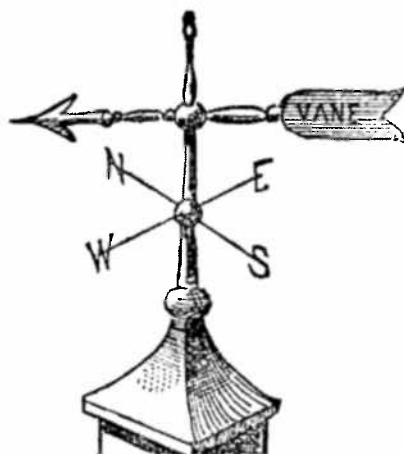
The rain gauge measures the amount of liquid precipitation that falls. It can measure either rain or, with added steps, the liquid equivalent of snow. The rain gauge has an outer cylinder, a measuring tube, and a funnel. The measuring tube measures to a hundredth inch. When it is full, it contains one inch of rain. When more than an inch falls, the extra flows into the outer cylinder. By carefully pouring the rain from the outer cylinder back into the measuring tube, a total rainfall amount can be accurately measured.

When snow is to be measured, bring the entire gauge into a warm room. Allow the snow to melt. Then follow the same procedures as above.

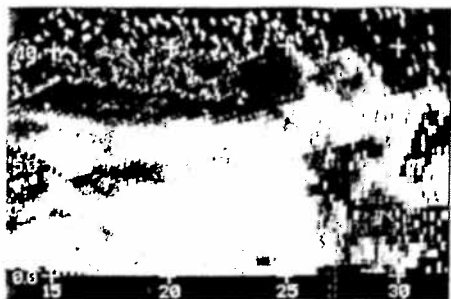


USING A WIND VANE

A weather vane is also called a wind vane. It is one of the oldest weather tools for measuring wind direction. It is still used today to measure the direction of the wind. Weather vanes can only measure wind direction a few yards (meters) off the ground. The weather vane spins on a rod and points in the direction from which the wind comes. Large, helium-filled weather balloons are used to measure winds high above the earth's surface. The balloons move with the same speed and direction as the wind. Weather vanes are usually found on the tops of buildings so they can catch an open breeze. They are placed on top of barns, houses, weather stations, hardware stores, and other places that use or sell weather tools. A weather vane is one of the most useful tools for forecasting because certain winds tend to bring certain weather patterns.



Doppler (dop/lər) radar, a type of radar that calculates distance and shows direction of movement.



The yellow and white areas represent precipitation moving toward the Doppler radar.



This weather satellite, GOES, tracks weather on the earth.

Doppler radar is an advanced type of radar that not only locates and tracks the presence of a storm, but also shows the direction the storm is moving. Doppler radar changes radio waves reflected from approaching precipitation to a higher frequency. Precipitation moving away reflects radio waves that are changed to a lower frequency. These different frequencies appear as different colors on the Doppler radar screen, as shown in the picture. By watching the movement of precipitation and accompanying winds in a storm, even violent weather patterns can be predicted.

Satellites, such as the one shown, are an important source of weather data. The first weather satellite was launched in 1960. It carried television cameras and stored the pictures on tape for later broadcast to the earth. Since then, many weather satellites have been launched. Some orbit the earth quickly, sending data about an entire path around the earth every 110 minutes. Other satellites are fixed over certain areas of the earth. They move at the same speed as the earth rotates. Therefore, these satellites send data only about the areas over which they are fixed. Meteorologists use satellite data to observe weather patterns over short and long periods of time.

Lesson Review

1. On what scientific principle do thermometers work?
2. How does air move between a high and a low?
3. What are three types of water in the air used to forecast weather?
4. How do weather balloons aid meteorologists?
5. **Challenge!** Why are all weather stations structured exactly alike?

Study on your own, pages 450–451.

FIND OUT ON YOUR OWN

The longest continuous record of weather data in the United States has been kept at New Haven, Connecticut, since 1781. Use a weather almanac or contact the nearest National Weather Service office to find out about weather data records for your area. Find out the highest and lowest temperatures, greatest wind speed, greatest rainfall, and deepest snowfall since records were started.